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(54) Position detecting apparatus.

(57) A method of detecting positions with a position detecting apparatus comprising:

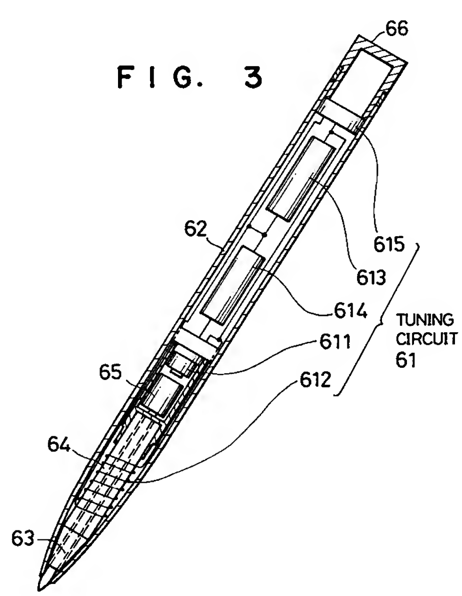
a position detecting section having a plurality of loop coils arrayed in a side-by-side-fashion in the direction of position detection for transmitting and receiving an electromagnetic wave with a predetermined frequency; and

a position pointer (60) having a tuning circuit (61) including a coil (612) and a capacitor (613,615) and adapted to resonate with said electromagnetic wave;

wherein the position of the position pointer (60) is determined from signals received by said loop coils from the tuning circuit (61) of the position pointer (60), when the latter is held in the vicinity of the position detecting section (10);

and wherein, when said position pointer (60) is pressed onto the input surface of the position detecting section, a switch (611) associated with said tuning circuit (61) is turned on to change the phase of the oscillating current excited in the tuning circuit, and the phase of the electromagnetic wave received by said loop coils is detected, thereby to determine the status of said switch (611).

F I G. 3



EP 0 587 200 A1

The present invention relates to a method of detecting positions and a position detecting apparatus and a position pointer for carrying out this method.

A conventional position detecting apparatus or digitizer is disclosed in JP-A-52-91 324.

A position pointer used with this apparatus has a magnetic member on one end of its body. A plurality of driving coils are placed in a position detecting section of the digitizer and are supplied with electric current sequentially, and a plurality of detecting coils which detect the induced voltage sequentially are arranged orthogonally to said driving coils. The driving coils and detecting coils are coupled electrocmagnetically. The position is detected by the variation of electromagnetic coupling due to the abovementioned magnetic member which approaches to or touches the position detecting section.

This method of position detection has the advantage that the position pointer needs not be connected to the digitizer by a cord and does not have to include a battery, neither. However, the digitizer cannnot identify whether the position pointer is placed in the very close proximity of the position detecting section or touches it.

It is accordingly an object of the present invention to provide a method of detecting positions in which neither a cord nor a battery is required for the position pointer and in which an information as to whether the position pointer is held in the vicinity of the position detecting section or whether it is pressed against the surface of the position detecting section can be notified to the position detecting apparatus together with the position information.

It is another object of the invention to provide a position detecting apparatus and a position pointer suitable for carrying out this method.

According to the invention, these objects are achieved with the features indicated in the independent claims.

A method of detecting positions utilizing the exchange of electromagnetic waves between loop coils provided in the position detecting area and a tuning circuit provided In the position pointer is claimed in the co-pending European patent application EP-A-0 259 894 from which the present application is derived.

A position pointer including a tuning circuit formed by a coil and a capacitor which are connected to each other by a switch is disclosed already In EP-A-0 254 297 which belongs to the prior art pursuant to Article 54(3) EPC.

With the method and apparatus according to the present invention, the position indicated by the position pointer can be detected already when the position pointer is approaching the position detecting section of the digitizer but is not yet actually pressed onto the surface thereof. The instant at which the position pointer touches the surface of the position detecting section is then detectable by a change in the phase of the electromagnetic wave emitted from the tuning circuit.

Further improvements of the invention are indicated in the dependent claims.

The objects, features and advantages of the invention will become clear from the following description of the preferred embodiments when the same is read in conjunction with the accompanying drawings.

Fig. 1 is a connection and block diagram showing the basic construction of a first embodiment of the position detecting apparatus in accordance with the present invention;

Fig. 2 is a block diagram showing details of a transmission circuit and a receiving circuit which are incorporated in the embodiment shown in Fig. 1;

Fig. 3 is an illustration of the internal structure of an input pen;

Fig. 4 is an illustration of the construction of a tuning circuit;

Fig. 5 is a waveform chart showing waveforms of signals obtained in various portions of the embodiment;

Figs. 6(a), 6(b) and 6(c) are timing charts for explaining the basic position detecting operation in the embodiment shown in Fig. 1;

Fig. 7 is a graph showing the levels of voltages induced in loop coils in the first cycle of detecting operation;

Fig. 8 is a graph showing the timing of the second and subsequent cycles of detecting operation;

Fig. 9 is an illustration of the construction of a second embodiment of the position detecting apparatus in accordance with the present invention; and

Fig. 10 is a timing chart similar to that shown in Fig. 8 but showing the timings used in the second embodiment.

Referring first to Fig. 1, a first embodiment of the position detecting apparatus in accordance with the present invention is constituted mainly by a position detecting section 10, a selection circuit 20, a connection switching circuit 30, a transmitting circuit 40, a receiving circuit 50, a position pointer 60 and a processing device 70.

The position detecting section 10 includes a plurality of parallel conductors which are arrayed in a side-by-side fashion in the direction of position detection. In the illustrated embodiment, 48 loop coils 11-1 to 11-48 are arrayed in the direction of position detection shown by an arrow ⓐ. More specifically, these loop coils 11-1 to 11-48 are arranged in parallel in such a manner as to partially

overlap the adjacent loop coils. Although in the illustrated embodiment each loop coil has a single turn, this is not exclusive and each loop coil may have two or more turns.

These loop coils may be formed by forming a plurality of parallel conductors by, for example, etching on a known print substrate and then suitably connecting these conductors by jumper lines such as to form the plurality of loop coils, thereby forming the position detecting section 10.

The selection circuit 20 has a function for successively selecting one from among the plurality of loop coils 11-1 to 11-48. The loop coils 11-1 to 11-48 have one ends connected to a first group of terminals 21 and the other ends connected to the other group of terminals 22. The selection circuit 20 has a selection contact 23 for selecting one of the terminals 21 of the first group and a selection contact 24 for selecting one from the second group of terminals 22. The selection contacts 23 and 24 are operatively connected to each other so that they select both ends of the same loop coil, thereby enabling the successive loop coils to be selected one after another. This selection circuit can simply be constructed by combining a multiplicity of multiplexers which are known per se.

The connection switching circuit 30 is adapted to connect the loop coil selected by the selection circuit 20 alternatingly to the transmission circuit 40 and the receiving circuit 50. The connection switching circuit 30 has selection contacts 31 and 32 to which are connected to the selection contacts 23 and 24 of the selection circuit 20 mentioned before. The connection switching circuit 30 also has terminals 33 and 35 connected to two output terminals of the transmission circuit 40 and terminals 34 and 36 connected to two input terminals of the receiving circuit 50. The selection contact 31 adapted to select one of the terminals 33 and 34 and the selection contact 32 adapted to select one of the terminals 35 and 36 are operatively connected to each other so that they are switched simultaneously to connect the selected loop coil either to the transmission circuit 40 or to the receiving circuit 50 in accordance with a later-mentioned transmission/receiving signal.

The connection switching circuit 30 also can be constructed by known multiplexers.

Fig. 2 shows details of the transmission circuit 40 and the receiving circuit 50. The transmission circuit 40 is constituted mainly by an oscillator 41, a frequency divider 42, NAND gates 43, 44, an EXCLUSIVE OR (EXOR) gate 45 and a driving circuit 46. On the other hand. the receiving circuit 50 is mainly constituted by an amplifier 51, phase detectors 52, 53, and low-pass filters (LPF) 54, 55.

A position pointer 60, which will be referred to as "input pen" hereinafter, has a tuning circuit 61 which includes a coil and a capacitor. As will be seen from Fig. 3, the input pen 60 has a pen holder 62 made of a non-metallic material such as a synthetic resin. The pen holder 62 receives, as mentioned from the pointing end, a pointing member 63 similar to the core of a ball point pen, a ferrite core 64 having an aperture which slidably receives the pointing member 63, a coiled spring 65, and a tuning circuit 61 constituted by a coil 612 wound around the ferrite core 64, capacitors 613, 614 and a variable capacitor 615. The end of the pen holder 62 opposite to the pointing end is capped as by 66.

As will be understood also from Fig. 4, the capacitor 613 and the variable capacitor 615 are connected in parallel to each other and both ends of this parallel connection are connected to the coil 612, thus constituting a parallel resonance circuit which is known per se. The reactance and capacitances of the coil 612, capacitor 613 and the variable capacitor 615 are so determined that the tuning circuit can resonate with the frequency of the electric wave produced by the loop coil of the position detecting section 10.

On the other hand, the capacitor 614 is connected to both ends of the coil 612 through the switch 611. The capacitor 614 has a function to delay the phase of the electric current in the above-mentioned parallel resonance circuit by a predetermined angle, when the switch 611 is turned on. When the pointing end of the pointing member 63 is pressed onto the input surface (not shown) of the position detecting section 10, the switch 611 is pressed by the rear end of the pointing member 63 through the coiled spring 65, whereby the switch 611 is turned on.

The processing device 70 controls the switching between the successive loop coils in accordance with a later-mentioned transmission/receiving switching signal and the output of the receiving circuit 50.

The operation of this embodiment will be described hereinunder. The description will be commenced first in regard to the exchanges of electric waves between the position detecting section 10 and the input pen 60, as well as signals obtained as a result of the exchange of the electric waves, with specific reference to Fig. 5.

Clock pulses of a predetermined frequency, e.g., 4 MHz produced by the oscillator 41 are demultiplied by the frequency divider 42 into signals of 1/4, 1/8 and 1/256 frequencies. A pulse signal A of 500 KHz, obtained by demultiplication into 1/8 frequency, is input to one of the input terminals of the NAND gate 43, while the other input terminal of the NAND gate 43 receives a transmission/receiving switching signal B of 15.625 KHz obtained by demultiplication into 1/256 fre-

quency. The output of the NAND gate 43 is inverted through the NAND gate 44 so that a signal C, which outputs a pulse signal of 500 KHz at an interval of 32 μsec, is obtained.

The signal C is converted into a balance signal by means of the driving circuit 46 and is delivered to one 11-i of a plurality of loop coils constituting the position detection section 10 through the connection switching circuit 30 and the selection circuit 20, so that the loop coil 11-i generates an electric wave corresponding to the signal C mentioned before.

If the input pen 60 has been held in the vicinity of the loop coil 11-i of the position detecting section 10 substantially perpendicularly to the position detecting section 10, the electric wave generated by the loop coil 11-i excites the coil 612 of the input pen 60, so that a voltage D is induced in the tuning circuit 61 in synchronism with the signal C.

The receiving period begins when the duration of the signal C expires. As the receiving period starts, the loop coil 11-i is connected to the receiving circuit 50 so that the electric wave from the loop coil 11-i extinguishes without delay. However, since no change is caused in the circuit elements of the tuning circuit 61 of the input pen 60, the induced voltage is progressively attenuated.

The voltage D induced in the tuning circuit 61 generates an electric current which flows through the coil 612. In consequence, the coil 612 generates an electric wave which acts to excite the loop coil 11-i which is connected to the receiving circuit 50, so that a voltage E is induced in the loop coil 11-i.

The connection switching circuit 30 is switched by the transmission/receiving switching signal B so that it picks up the signal from the loop coil 11-i only during suspension of transmission of the signal from the loop coil 11-i. Thus, the connection switching circuit 30 delivers the signal voltage E induced in the loop coil 11-i to the amplifier 51. The amplified signal F derived from the amplifier 51 is delivered to the phase detectors 52 and 53.

The phase detector 52 also receives the pulse signal A mentioned before as a phase detecting signal. If the phase of the received signal F coincides with the phase of the pulse signal A, the phase detector 52 produces a signal G which is formed by inverting the received signal F to the positive or plus side. The signal G is converted, by the low-pass filter 54 having a sufficiently low cut-off frequency, into a flat signal H having a voltage level of VH and the thus obtained signal H is delivered to the processing device 70.

The phase detector 53 also receives, as the detecting signal, a pulse signal A' (not shown) which is formed by the EXOR circuit 45 as Exclusive OR of the pulse signal A and a pulse signal which has a frequency twice as high the frequency of the pulse signal A. Thus, the detecting signal A' has the same frequency as the pulse signal A and a phase which is 90° behind the phase of the pulse signal A. If the phase of the received signal F coincides with the phase of the pulse signal A', the phase detector 53 produces a signal I which is obtained by inverting the received signal F to the negative or minus side. The signal I is input to the low-pass filter 55 having a sufficiently low cut-off frequency so that it is converted into a flat signal J of a voltage level -VJ. The thus obtained signal I is delivered to the processing device 70.

If the switch 611 has been turned off in the input pen 60, the phases of the voltage and the current in the tuning circuit at the resonance frequency coincide with each other as explained before. In consequence, the phase of the received signal F and the phase of the pulse signal A coincides with each other. In this state, the voltage appears only in the signal H but no voltage appears in the signal J.

Conversely, if the switch 611 in the input pen 60 has been turned on, the phase of the electric current in the tuning circuit 61 is delayed by a predetermined angle from the phase of the voltage at the resonance frequency, as explained before. Consequently, the phase of the received signal F is delayed by a predetermined angle from the phase of the pulse signal A. In this case, therefore, voltages appear both in the signals H and J. It will be understood, however, the voltage appears only in the signal J if the delay of the phase is 90°.

The signals H and J delivered to the processing device 70 70 are converted into corresponding digital signals and are subjected to arithmetic operation in accordance with the following formulae (1) and (2).

$$V_x = (V_H^2 + V_J^2)^{1/2} \quad (1)$$

$$V_\theta = \tan^{-1}(VJ/VH) \quad (2)$$

The symbol V_x represents a voltage value which is proportional to the distance between the input pen 60 and the loop coil 11-i, while V_θ represents a voltage value which is proportional to the phase difference between the voltage and the current in the tuning circuit 61 of the input pen 60.

When the loop coil 11-i which exchanges the electric waves with the input pen 60 is switched from one to another, the level of the voltage V_x is changed so that the position of the input pen 60 can be detected by examining the voltage value V_x as will be explained later.

On the other hand, the voltage value V_θ varies only in response to the turning of the switch 611 into on and off states. It is thus possible to distin-

guish the states of the switch 611 by comparing the voltage value V_θ with a predetermined threshold voltage.

A description will be made hereinunder as to the position detecting operation performed by the apparatus of the present invention, with reference to Figs. 6 to 8.

The position detecting operation is commenced as the power supply is turned on to supply electric power to the whole apparatus. The processing device 70 then delivers to the selection circuit 20 an instruction for enabling the selection circuit 20 to select the first loop coil 11-1 from among the lop coils 11-1 to 11-48 constituting the position detecting section 10, thereby connecting the loop coil 11-1 to the connection switching circuit 30. Then, the connection switching circuit 30 connects the loop coil 11-1 alternatingly to the transmission circuit 40 and the receiving circuit 50 in accordance with the transmission/receiving switching signal B.

In the transmission period of 32 µsec, the transmission circuit 40 delivers 16 pieces of pulse of 500 KHz to the loop coil 11-1, as shown in Fig. 6(a). The switching between the transmission and receiving is repeated seven times for each loop coil, e.g., for the lop coil 11-1, as shown in Fig. 6-(b). The total period of seven cycles of switching between transmission and receiving corresponds to the period (448 µsec) over which each coil is selected.

In consequence, the phase detectors 52 and 53 of the receiving circuit 50 produce induced voltages for each of seven signal receiving periods of each loop coil. The induced voltages thus obtained are averaged by the low-pass filters 54 and 55 as explained before, and are then delivered to the processing device 70. These two types of induced voltages are processed by the processing device 70 in accordance with the formulae mentioned before so as to be converted into the detection voltage V_{x1} corresponding to the distance between the input pen 60 and the loop coil 11-1.

Subsequently, the processing device 70 delivers an instruction to the selection circuit 20 for enabling the latter to select the second loop coil 11-2 so that the second loop coil 11-2 is connected to the connection switching circuit 30. Then, a process similar to that explained in connection with the first loop coil 11-1 is executed so that a detection voltage V_{x2} corresponding to the distance between the input pen 60 and the loop coil 11-2 is determined and stored. The described operation is conducted for all the remaining loop coils 11-3 to 11-48 by successively connecting these loop coils 11-3 to 11-48 to the connection switching circuit 30, whereby the respective detection voltages V_{x1} to V_{x48} corresponding to the distances between the input pen 60 and the respective lop coils are obtained as shown in Fig. 6(c). It is to be noted, however, that Fig. 6(c) shows only some of such detection voltages.

Actually, the detection voltage appears only in several loop coils around the loop coil which is closest to the position (xp) where the input pen 60 is placed, as shown in Fig. 7.

When the levels of the voltages stored as explained above exceed a predetermined detection level, the processing device 70 computes the coordinate values representing the position of the input pen 60 by processing these stored voltage values, and transfers the thus computed coordinate values to a memory section which is not shown.

When the first position detecting operation is completed in the manner described hereinbefore, the processing device 70 delivers an instruction for enabling the selection circuit 20 to select only a predetermined number of loop coils, e.g., 10 loop coils, around the loop coil which has produced the maximum detection voltage. The position detecting operation is then conducted on these selected loop coils and the coordinate value representing the position of the input pen 60 is determined and delivered to the memory section so as to renew the content of the memory section.

Meanwhile, the processing device 70 computes, not only the detection voltages V_{x1} to V_{x48} for the respective but also the detection voltage V_θ corresponding to the phase difference between the voltage and the current in the tuning circuit 61 of the input pen 60, and compares the thus obtained detection voltage V_θ with a predetermined threshold voltage, for each of the successive loop coils. Therefore, when the switch 611 is turned on in the input pen 60, the on state of the switch 611 is detected by the processing device 70 from the result of the comparison between the detection voltage V_θ and the threshold value, and transmits the above-mentioned coordinate value obtained at this moment to an external device such as a computer (not shown).

Fig. 8 shows the timings in the second and other subsequent cycles of detecting operation performed by the processing device 70. Referring to this Figure, the period "level check" is a period in which a check is conducted as to whether the maximum value of the detection voltage reaches the aforementioned detection level, and also as to whether which one of the loop coils exhibits the maximum detection voltage. If the level of the maximum detection voltage is below the detection level, the control device 70 stops the computation of the coordinate values and determines the central one of a plurality of loop coils which are to be selected in the next cycle of the detecting operation.

A preferred method of determining the coordinate value xp is to approximate, by a suitable function, the waveform of a curve representing the detection voltages V_{x1} to V_{x48} in a region around a peak of the curve and to determine the coordinate value of the peak in such a function.

For instance, referring to Fig. 6(c), the maximum detection voltage V_{x3} and detection voltages V_{x2} and V_{x4} on both sides of the maximum detection voltage can be approximated by a quadratic function. In such a case, the coordinates value xp of the position of the input pen 60 can be determined as follows. The coordinates values of the centers of the respective loop coils 11-1 to 11-48 are expressed by x1 to x48 and the pitch of the array of the loop coils is expressed by Δx. The following formulae are derived from the relationships between the detection voltages and the coordinate values of the respective loop coils.

$$V_{x2} = a(x2 - xp)^2 + b \quad (3)$$

$$V_{x3} = a(x3 - xp)^2 + b \quad (4)$$

$$V_{x4} = a(x4 - xp)^2 + b \quad (5)$$

where, a and b represent, respectively constants which meet the condition of $a < 0$.

It will also be understood that the following relationships exist.

$$x3 - x2 = \Delta x \quad (6)$$

$$x4 - x2 = 2\Delta x \quad (7)$$

The formulae (4) and (5) therefore can be reformed as follows on condition of the relationships shown by the formulae (6) and (7).

$$xp = x2 + \Delta x/2\{(3V_{x2} - 4V_{x3} + V_{x4})/(V_{x2} - 2V_{x3} + V_{x4})\} \quad (8)$$

It will be understood that the coordinate value xp of the input pen 60 can be determined by extracting, from the group of the detection voltages V_{x1} to V_{x48}, the maximum value of the detection voltage as determined through the level check and the voltage values obtained immediately before and immediately after the maximum value of the detection voltage, and conducting a computation in accordance with the formulae (8) by using these three voltage values corresponding to the voltages V_{x2}, V_{x3} and V_{x4} in formula (8) and the coordinate of the loop coil which has been checked immediately before the check of the loop coil which exhibits the maximum detection voltage, i.e., the coordinate value x2 in the formula (8).

The number of the loop coils employed in the described embodiment, as well as the manner in which the loop coils are arranged, is illustrative and is not intended for restricting the scope of the invention.

Fig. 9 shows a second embodiment of the present invention designed for two-dimensional position detection. This embodiment has, therefore, X- and Y-direction position detecting sections 81 and 82, X- and Y-direction selection circuits 83 and 84, and X- and Y-direction connection switching circuits 85 and 86, which have constructions basically the same as the position detection section 10, selection circuit 20 and the connection switching circuit 30 used in the first embodiment designed for one-dimensional position detection. The constructions of these portions, therefore, are not shown in detail in Fig. 9. It is to be understood, however, that the loop coils constituting the X-direction position detecting section are arrayed in X-direction while the loop coils constituting the Y-direction position detecting section are arrayed in Y-direction , and these groups of loop coils are superposed so as to orthogonally cross each other. This second embodiment also incorporates a processing device 87 which is materially the same as the processing device 70 used in the first embodiment, except that it controls the position detecting operation such that the position detecting in the X-direction and the position detection in the Y-direction are conducted alternately. The timings in the second and subsequent cycles of position detecting operation performed by the processing device 87 are shown in Fig. 10.

Thus, the second embodiment of the present invention enables the position pointed by the position pointer to be detected two-dimensionally, i.e., both in X- and Y-directions, in terms of the X- and Y-coordinates values. The second embodiment further has a transmission circuit 40, receiving circuit 50 and an input pen 60 which may be the same as those used in the first embodiment.

Claims

1. A method of detecting positions with a position detecting apparatus comprising:

   a position detecting section (10) having a plurality of loop coils (11-1 to 11-48) arrayed in a side-by-side-fashion in the direction of position detection for transmitting and receiving an electromagnetic wave with a predetermined frequency; and

   a position pointer (60) having a tuning circuit (61) including a coil (612) and a capacitor (613,615) and adapted to resonate with said electromagnetic wave;

   wherein the position of the position pointer

(60) is determined from signals received by said loop coils from the tuning circuit (61) of the position pointer (60), when the latter is held in the vicinity of the position detecting section (10);

and wherein, when said position pointer (60) is pressed onto the input surface of the position detecting section (10), a switch (611) associated with said tuning circuit (61) is turned on to change the phase of the oscillating current excited in the tuning circuit, and the phase of the electromagnetic wave received by said loop coils is detected, thereby to determine the status of said switch (611).

2. A method as claimed in claim 1, wherein a voltage value (V_x) is derived from the signal received by each of said loop coils (11-1 to 11-48), said voltage value being proportional to the distance between the position pointer (60) and the respective loop coil, and the coordinate values representing the position of the position pointer (60) are computed by processing the voltage values thus obtained.

3. A method as claimed in claim 2, wherein the coordinate value obtained in a first position detecting operation is stored in a memory section and the loop coil which has produced the maximum voltage value is identified, and then only a predetermined number of loop coils around this loop coil is selected, and the position detecting operation is conducted on these selected loop coils and the coordinate value representing the position of the position pointer (60) is determined and delivered to the memory section so as to renew the content of the memory section.

4. A method as claimed In claim 2 or 3, wherein the waveform of a curve representing the voltage values (V_x) received from a plurality of loop coils in a region around a peak of the curve is approximated by a suitable function, and the coordinate value (xp) of the peak of this function is determined as the coordinate value representing the position of the position pointer (60).

5. A method as claimed in anyone of the claims 2 to 4, wherein:

the phase of the current in the tuning circuit (61) is shifted by 90° when the switch (611) is turned on,

two signals (H,J) are derived from the output of each loop coil, one of these signals (H) being selectively responsive to the electromagnetic wave received with no phase shift and the other one (J) being selectively responsive to the electromagnetic wave with the phase shift of 90°, and said voltage value V_x is computed pursuant to the formula

$$Vx = (V_H^2 + V_J^2)^{1/2,}$$

wherein V_H and V_J are the values of said two signals (H,J), respectively.

6. A method as claimed in claim 5, wherein a value V_θ is calculated pursuant to the formula

$$V_\theta = \tan^{-1} (V_J/V_H)$$

and the status of the switch (611) is determined by comparing said value value.

7. A position detecting apparatus for carrying out the method as claimed in anyone of the preceding claims, comprising:

a transmission circuit (40) for generating an A.C. signal of a predetermined frequency to be delivered to said loop coils (11-1 to 11-48),

a receiving circuit (50) adapted to detect an induced voltage of a frequency substantially the same as that of said A.C. signal in a selected one of said loop coils,

first phase detector means (52,54) responsive to the output of said receiving circuit (50) and to said A.C. signal for delivering a signal (H) which corresponds to an induced voltage of the same phase as said A.C. signal,

phase shift means (45) responsive to said A.C. signal for generating a signal (A') which has the same frequency as said A.C. signal but a different phase,

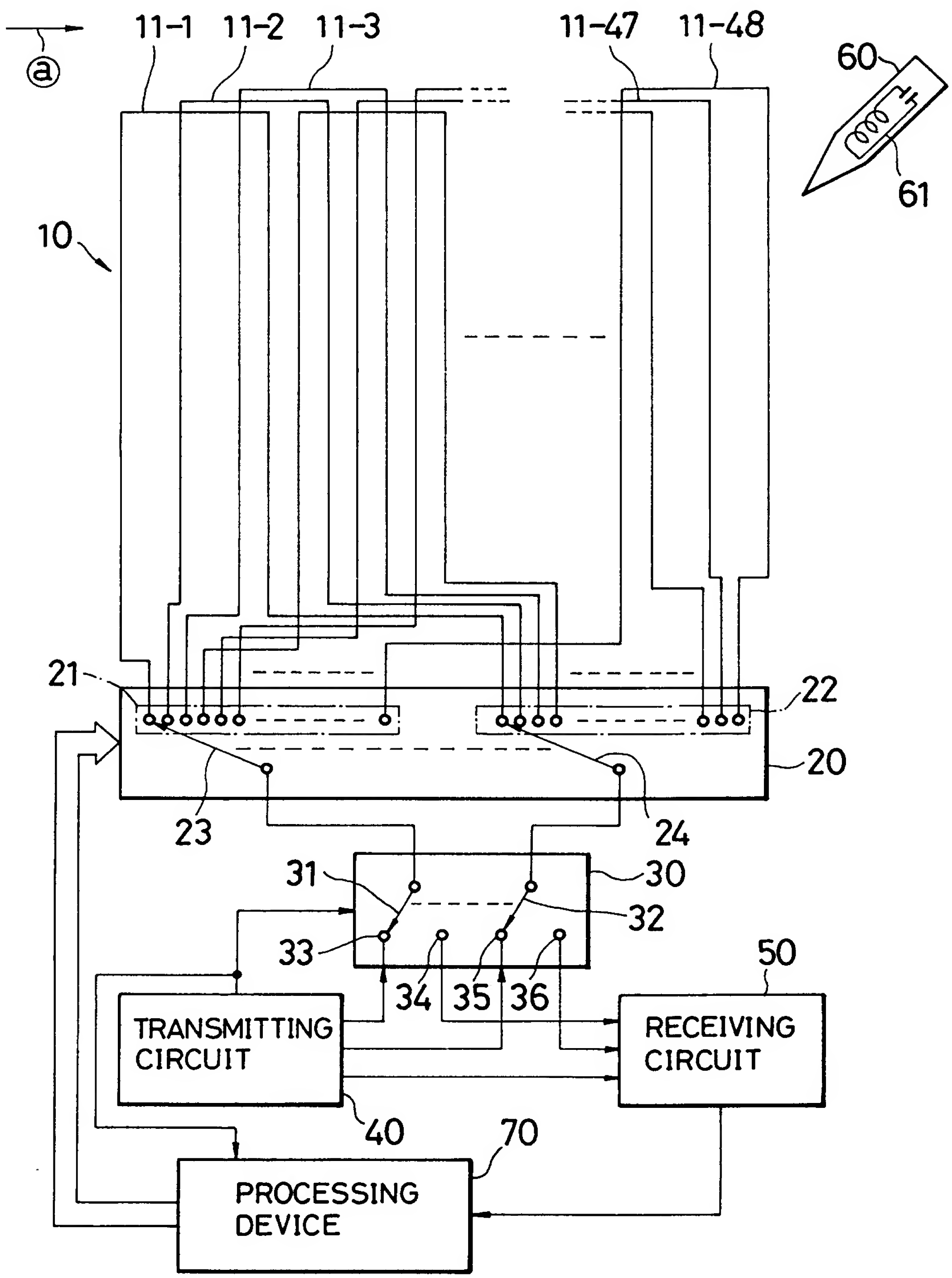
second phase detector means (53,55) responsive to the output of said receiving circuit (50) and the output of said phase shift means (45) for generating an output signal (J) which corresponds to an induced voltage of the same phase as the signal (A') delivered by said phase shift means, and

a processing device (70) for determining the position pointed by said position pointer (60) and the status of said switch (611) on the basis of the signals (H,J) provided by said first and second phase detector means.

8. A position pointer (60) for use with a position detecting apparatus for carrying out the method as claimed in anyone of the claims 1 to 6, said position pointer (60) comprising a pen holder (62), a pointing member (63) which is similar to the core of a ballpoint pen, a ferrite core (64) having an aperture which slideably receives the pointing member (63), and a coil-

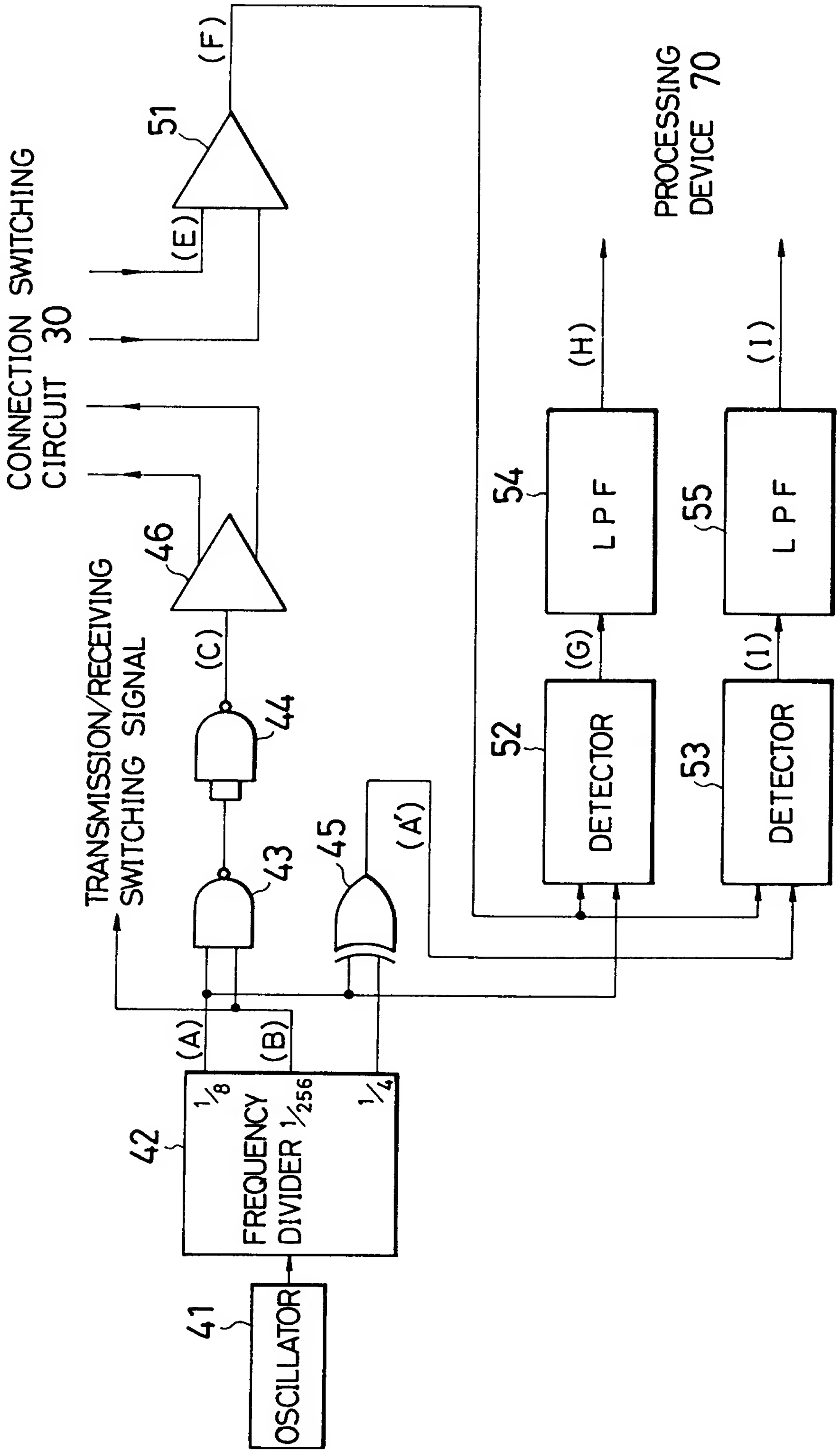
ed spring (65) biasing said pointing member (63) so that its pointed end projects from the tip end of the pen holder (62), wherein said coil (612) of said tuning circuit (61) is wound around the ferrite core (64) and said switch (611) is arranged to be pressed by the rear end of said pointing member (63) when the pointed end thereof is pressed onto the input surface of the position detecting section (10).

FIG. 1



ⓐ
11-1
11-2
11-3
11-47
11-48
60
61
10
21
22
20
23
24
31
30
32
33
34
35
36
50
TRANSMITTING CIRCUIT
RECEIVING CIRCUIT
40
70
PROCESSING DEVICE

FIG. 2


OSCILLATOR
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FREQUENCY DIVIDER 1/256
42
1/8
1/4
(A)
(B)
(A')
43
44
45
46
51
(C)
(E)
(F)
(G)
(H)
(I)
TRANSMISSION/RECEIVING SWITCHING SIGNAL
CONNECTION SWITCHING CIRCUIT 30
DETECTOR
52
DETECTOR
53
LPF
54
LPF
55
PROCESSING DEVICE 70

FIG. 3

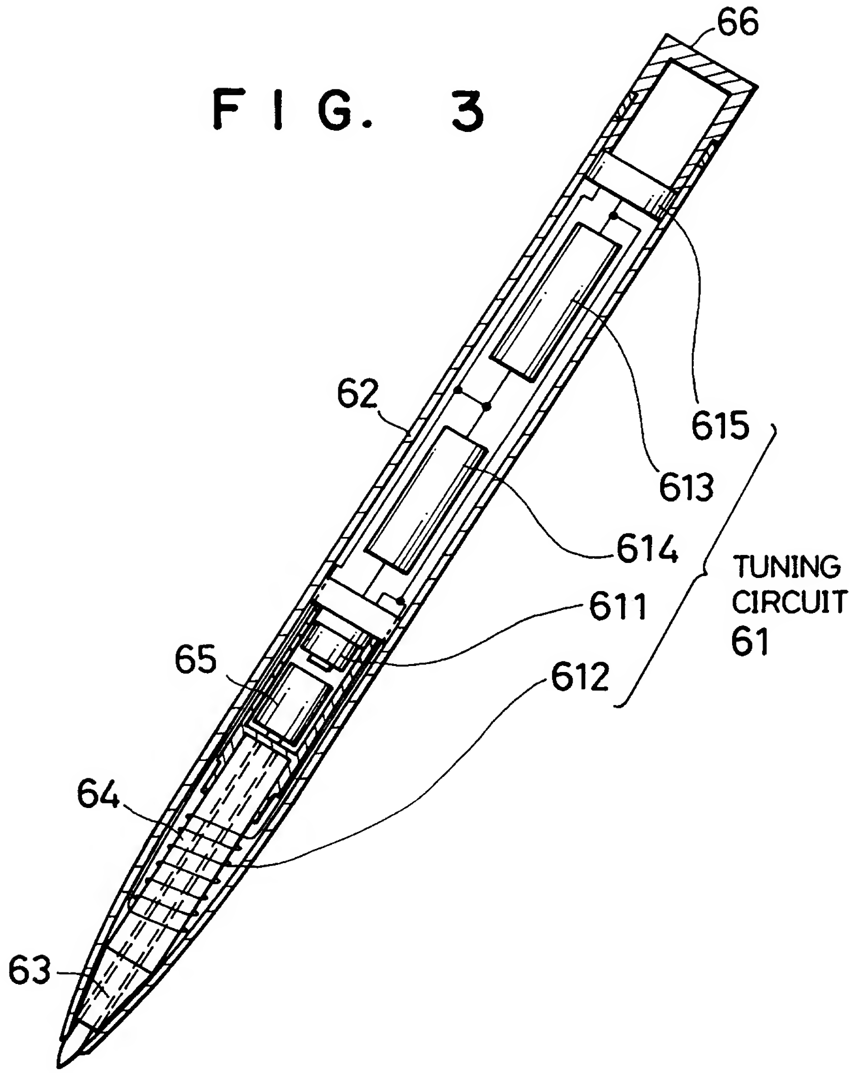

66
62
615
613
614
TUNING
CIRCUIT
61
611
65
612
64
63

FIG. 4

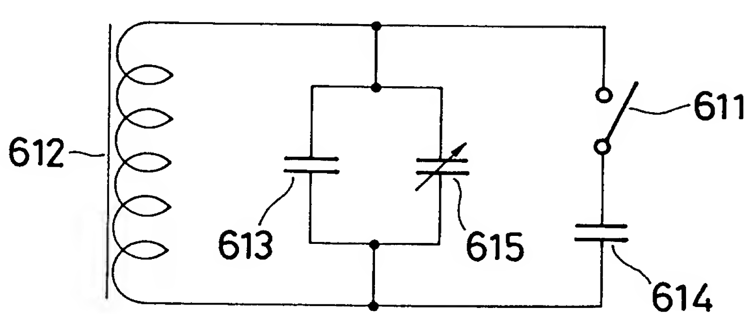

612
611
613
615
614

FIG. 5

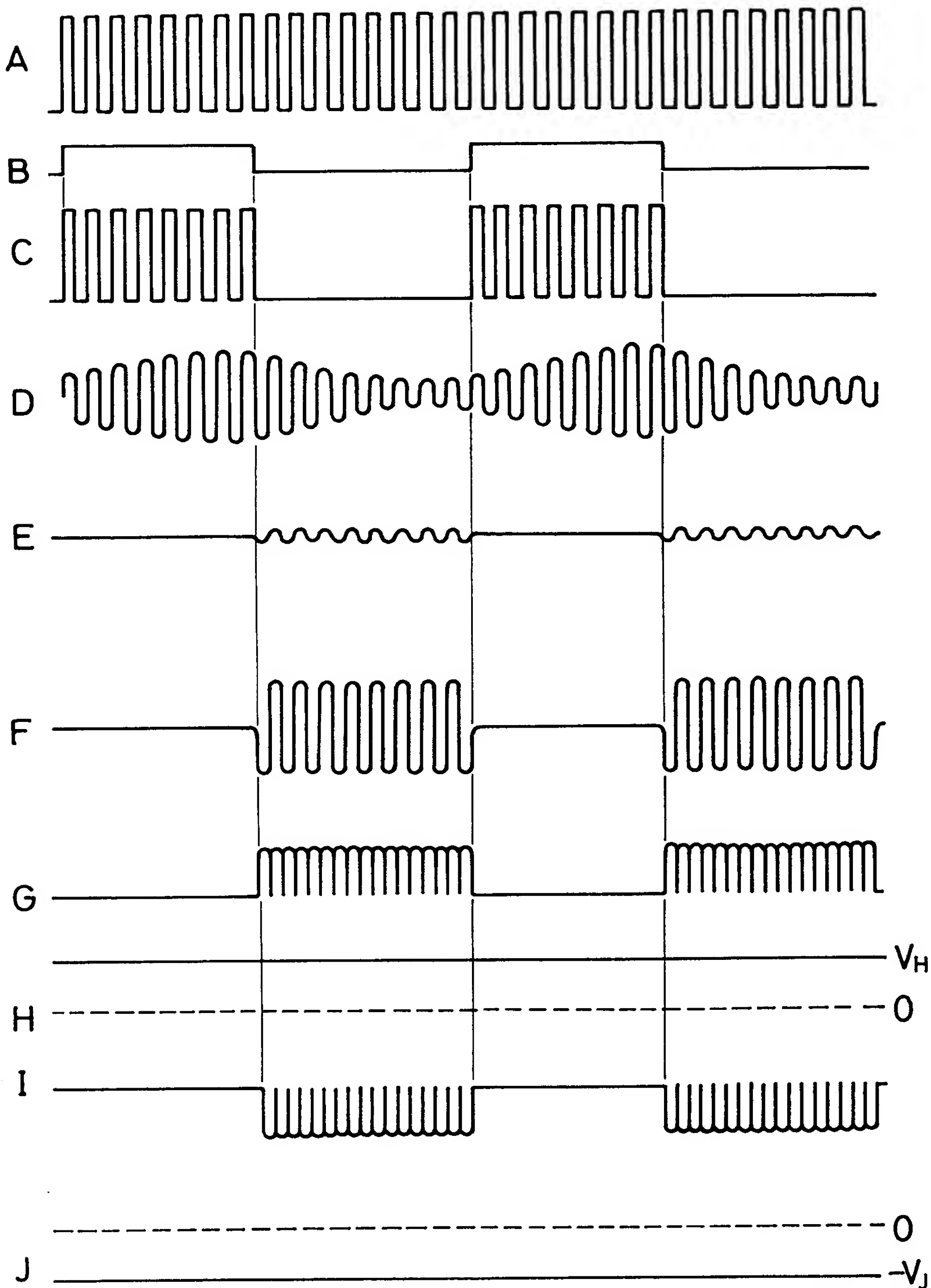


FIG. 6

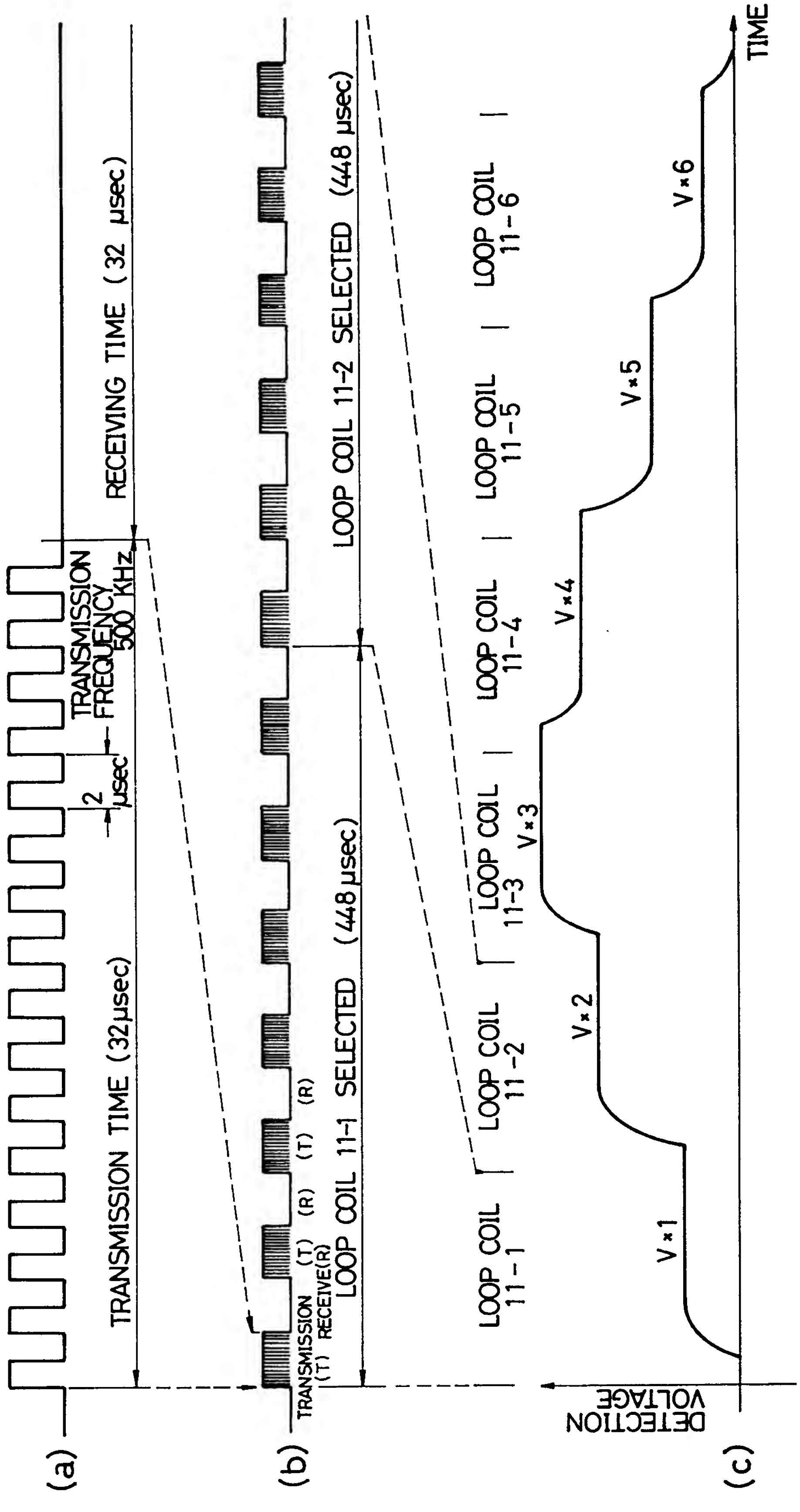

(a)
TRANSMISSION TIME (32μsec)
2 μsec
TRANSMISSION FREQUENCY 500 KHz
RECEIVING TIME (32 μsec)
(b)
TRANSMISSION (T) RECEIVE (R)
(T) (R) (T) (R)
LOOP COIL 11-1 SELECTED (448μsec)
LOOP COIL 11-2 SELECTED (448 μsec)
LOOP COIL 11-1
LOOP COIL 11-2
LOOP COIL 11-3
LOOP COIL 11-4
LOOP COIL 11-5
LOOP COIL 11-6
(c)
DETECTION VOLTAGE
V×1
V×2
V×3
V×4
V×5
V×6
TIME

FIG. 7

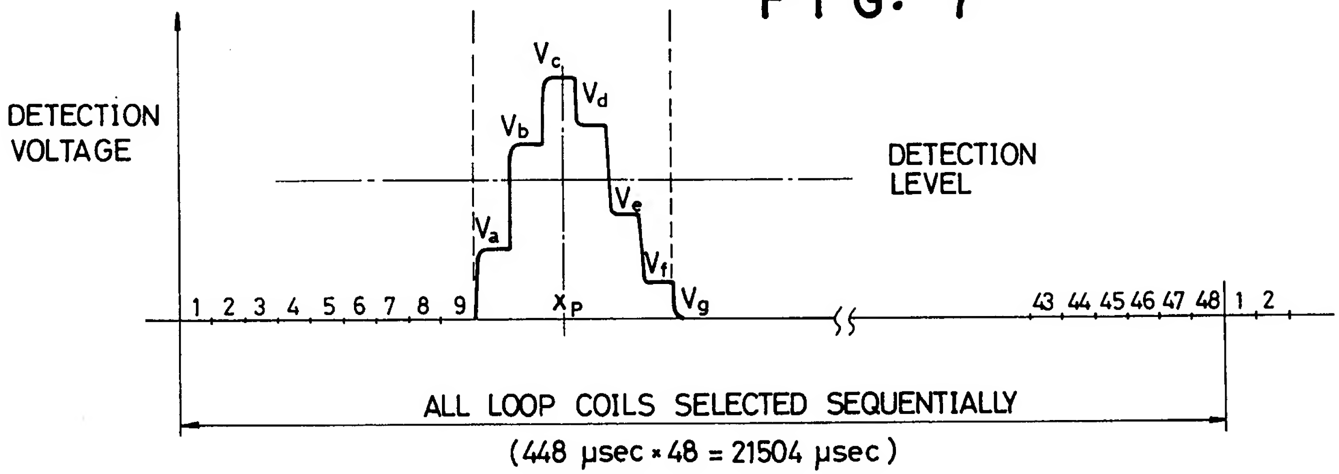

DETECTION
VOLTAGE
Va
Vb
Vc
Vd
Ve
Vf
Vg
DETECTION
LEVEL
1 2 3 4 5 6 7 8 9
XP
43 44 45 46 47 48 1 2
ALL LOOP COILS SELECTED SEQUENTIALLY
(448 μsec × 48 = 21504 μsec)

FIG. 8

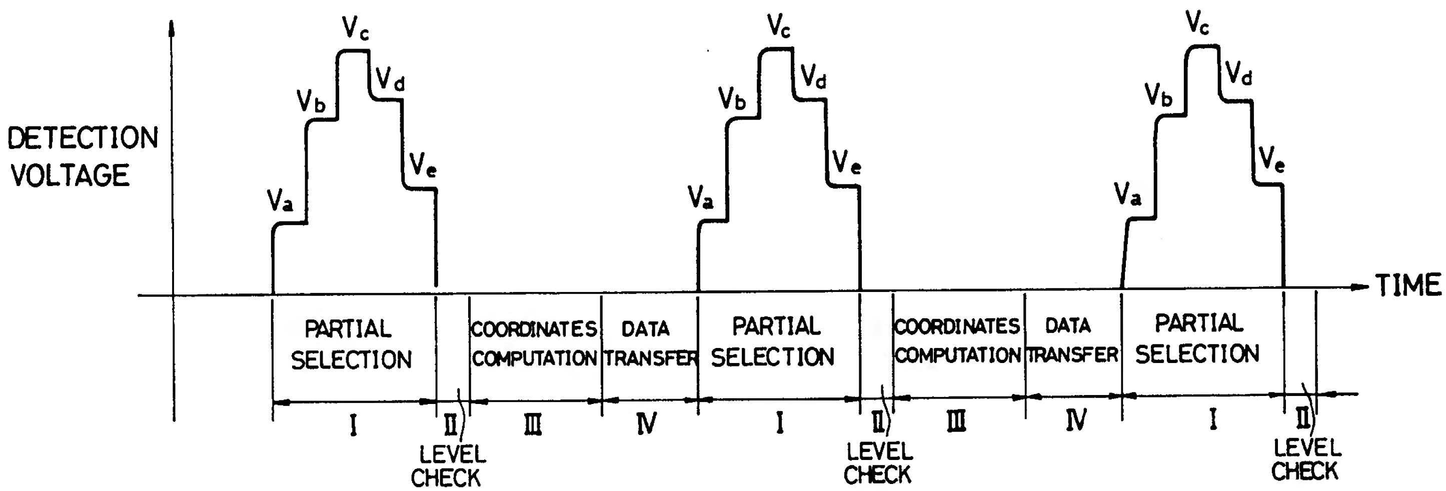

DETECTION
VOLTAGE
Va
Vb
Vc
Vd
Ve
TIME
PARTIAL
SELECTION
COORDINATES
COMPUTATION
DATA
TRANSFER
I
II
III
IV
LEVEL
CHECK

FIG. 9

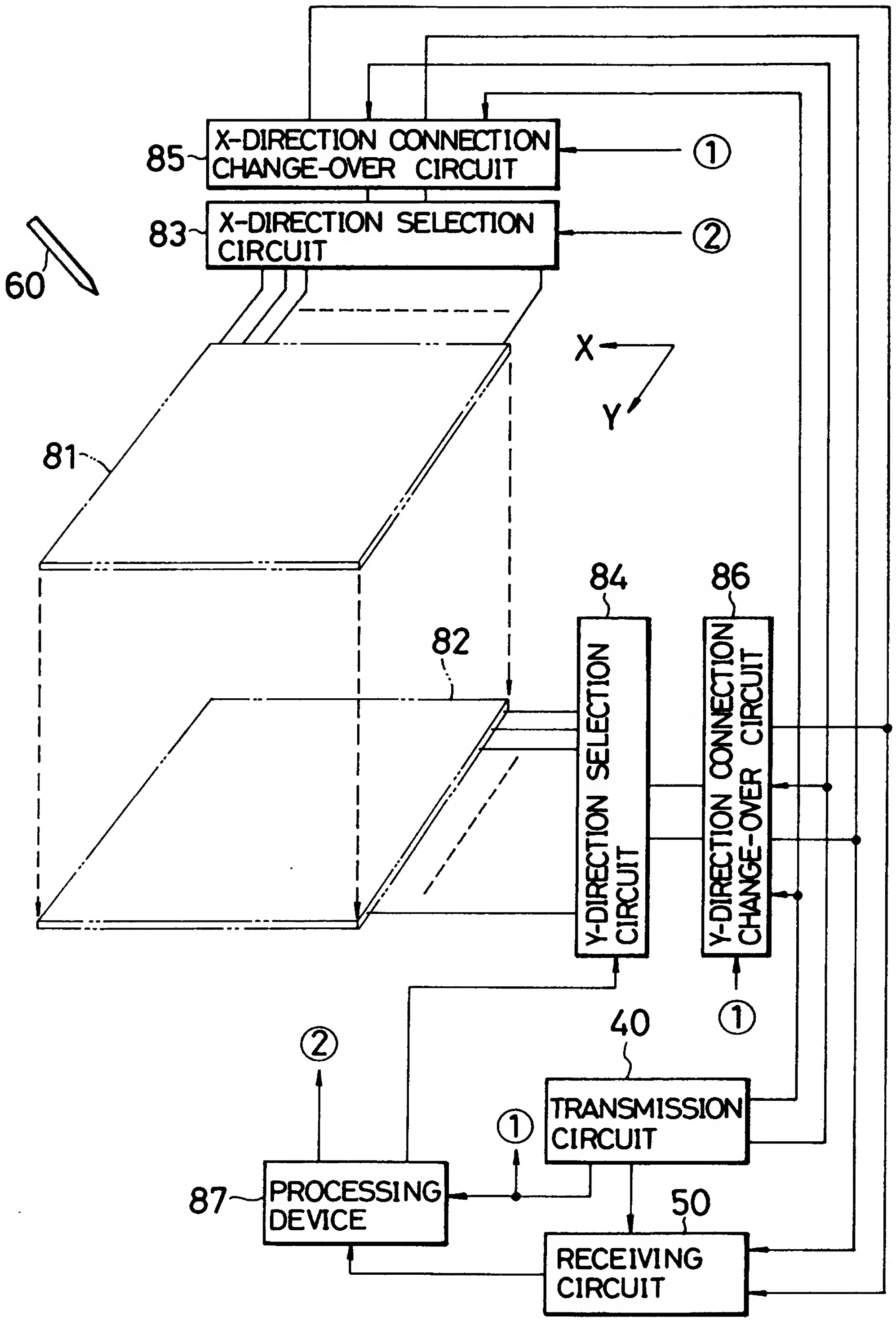
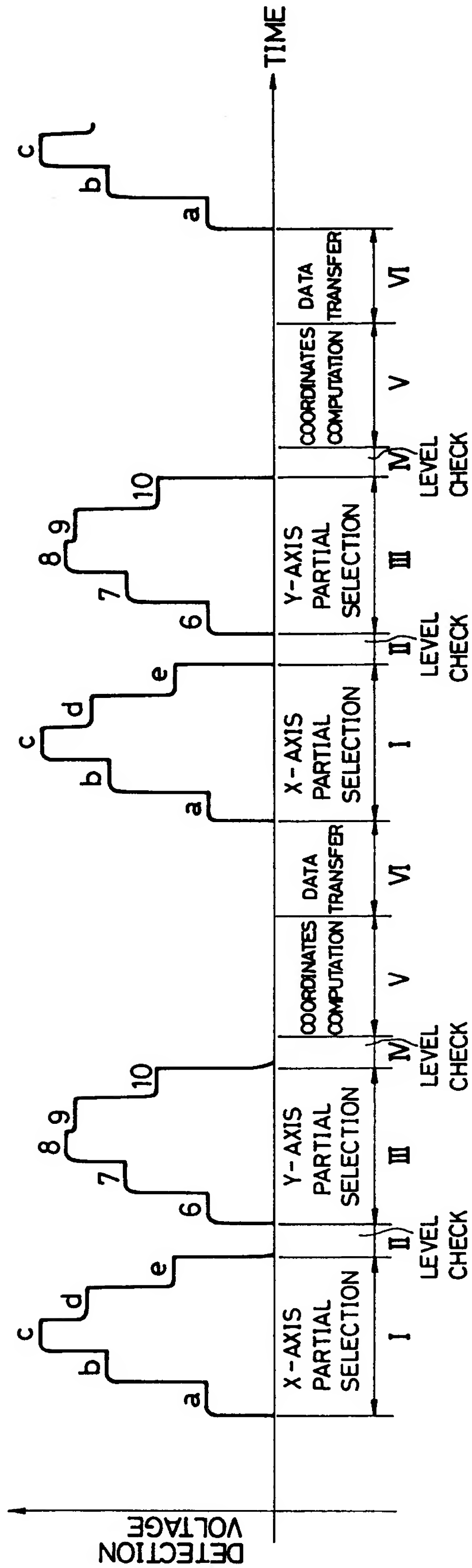

X-DIRECTION CONNECTION CHANGE-OVER CIRCUIT
85
X-DIRECTION SELECTION CIRCUIT
83
①
②
60
X
Y
81
82
84
86
Y-DIRECTION SELECTION CIRCUIT
Y-DIRECTION CONNECTION CHANGE-OVER CIRCUIT
①
40
②
TRANSMISSION CIRCUIT
①
50
87
PROCESSING DEVICE
RECEIVING CIRCUIT

FIG. 10


DETECTION VOLTAGE
TIME
X-AXIS PARTIAL SELECTION
Y-AXIS PARTIAL SELECTION
LEVEL CHECK
COORDINATES COMPUTATION
DATA TRANSFER
I
II
III
IV
V
VI
a
b
c
d
e
6
7
8
9
10

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 93 11 8666

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.4)
A	EP-A-0 184 835 (WACOM COMPANY LTD.) * figures 1,7,10 * * page 7, line 20 - line 25 * * page 13, line 15 - page 15, line 15 * * page 16, line 16 - page 17, line 11 * ---	1-4,7,8	G06K11/10
A	GB-A-1 340 522 (J.E.RYLEY ET AL.,) * figure 5 * * page 3, line 117 - page 4, line 60 * ---	1-4,7	
A	US-A-4 205 199 (MOCHIZUKI) * figures 2-4,10 * * column 3, line 65 - column 6, line 49 * -----	1-4,7,8	
			TECHNICAL FIELDS SEARCHED (Int.Cl.4)
			G06K

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	6 January 1994	Weiss, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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